

Big Data Analytics for Supply Chain Mass Customization: Prospects, Challenges, and Opportunities

Guangchun Tian

Sichuan University-Pittsburgh Institute, Sichuan University, Chengdu, China, 610207

2021141520174@stu.scu.edu.cn

Abstract. In today's world, the topic of economic globalization is still on the rise, and trade between countries is becoming more and more frequent. At the same time of economic prosperity, customers' demand for products is clearer and more perfect, which brings more intense competition between countries and enterprises. As one of the four most important strategic resources in the 21st century, the supply chain also shows increasingly important positions in the wave of international competition. More accurate customization of customer demand has become particularly important to save resources, create better revenue, and accurately meet customer demand. Mass customization is built through big data analysis; supply chain management is mass customization's basis and starting point. Nowadays, flexible and changeable customer demand greatly improves the risk and pressure of enterprises, standing on the tip of the wind of digitalization, intelligence, and the use of information technology to improve the enterprise organizational structure and operational processes to become a problem for enterprises to change their problems, the use of big data for customization in the supply company to analyze the point of focus.

Keywords: Supply chain management, Big data analytics, Mass manufacturing, Personalization.

1. Introduction

In the early days, people in the use of warehouses were human warehouses, consuming a lot of time and energy, but also had a high degree of proficiency in workforce requirements; errors also often occurred. In the first and second industrial revolutions, humanity officially stepped into the era of mechanization with the help of conveyor belts, forklifts and other tools to improve efficiency. Later, mechanization was gradually transformed into automation with the help of computers. Nowadays, based on automation, intelligence is penetrating large-scale warehousing, saving more resources and time [1].

Since the 1950s, the number of multinational corporations (MNCs) has been increasing rapidly, and by the 1960s, there were more than 7,000 MNCs in developed countries. Now, the question of how multinational corporations can optimize their actions when conducting business in different regions needs an answer. GSCs integrate key processes dispersed across countries, from raw material suppliers to final consumers, to deliver products and services and exchange information to consumers and other stakeholders. Nowadays, GSCs are designed to globalize a series of supply chain processes such as transportation and warehousing, the globalization of major logistics links and operations, sourcing, outsourcing, and so on [2].

In today's world, economic globalization is still hot and continues to rise, and countries are trading more and more frequently. At the same time of economic prosperity, customers' demand for products is clearer and more perfect, which brings more intense competition between countries and enterprises. The issue of mass customization is an important problem for the development of enterprises, and it is essential to more accurate demand forecasting, gradually improve the customized design and mass production, and grasp the opportunity of the wind. Therefore, it is necessary to use big data analysis capability to make demand forecasts in supply chain mass customization.

The prediction model is constructed by big data analysis based on historical information and current data, and supply chain management is the basis and starting point of demand prediction, objectively due to the availability of data brought about by technological changes, subjectively due to the need for supply chain management to be more accurate. Many scholars have discussed the

"development history of the supply chain", "supply chain demand forecasting model", "integration of supply chain and information technology", "big data supply chain analysis capability", "supply chain management", and "supply chain management". Data supply chain analytics capability", "mass customization capability," and so on, so it is necessary to conduct a review. This paper aims to analyze the application of big data analytics in supply chain mass customization and discuss its significance, challenges, and future outlook. This article will sort out the above issues.

2. Computer-Driven and Big Data Applications

2.1. Supply Chain and Industry 4.0

As early as the beginning of the 21st century, the supply chain was defined by Fortune magazine as "one of the four most important strategic resources of this century, and an indispensable means for Fortune 500 companies to maintain strong competition". Currently, Industry 4.0 is sweeping the world, and the supply chain is gradually becoming a key factor in the success or failure of enterprises. Industry 4.0 aims to support the research development and innovation of a new generation of revolutionary technologies in the industrial field and to promote the transformation of the manufacturing industry to intelligence. A new round of scientific, technological, and industrial revolutions has emerged, leading to the strong rise of digital technology. Industrial digitization and digital industrialization have become important driving factors and features of the fourth industrial revolution. Accelerating the digital transformation of the supply chain is a strategic pivot and geese pattern for enterprises to discover new opportunities in the crisis and develop new ideas in the changing situation. In line with the development of the general situation, we will focus on promoting the new pattern and new concept of supply chain digital ecological construction, empowering the industry ecosystem with supply chain digitization, thus driving the high-quality development of enterprises [3].

2.2. Personalization and Customization

With the continuous improvement of social productivity science and technology and the popularization of information technology, consumer demand has gradually shown a trend of personalization and diversification, and the standardized and mass production methods of factories in the past have been subjected to an unprecedented impact. Enterprises use the Internet, mobile Internet, etc., to complete the connection with users, create a user aggregation platform, a multi-dimensional social platform through the analysis of user behavior and social relationships and other big data, accurate market prediction, accurate marketing, with the help of the platform's aggregation and interactive functions to achieve mass user interaction with the enterprise docking, so that large-scale personalized customization, accurate decision-making and so on has become possible. The traditional single channel, closed operation, one-way flow of enterprise user relationship needs to be fixed. The old demand positioning rough, market feedback lag, and other problems have been solved. New technological innovations, such as the Internet of Things, 3D printing, etc., are gradually integrated into manufacturing, personalized customization as the center, a new production structure, supply chain management as a carrier, and the real product realization "for the customer to create." Personalized customization is consumer-centered to meet the unique needs of the consumption model, with the progress of society and technology gradually developing [4]. The following is the development history of personalized customization:

Craftsman era: This is the earliest personalized customization mode. At this stage, artisans produced products by hand according to the needs of the order, and almost every product was unique.

The era of the Industrial Revolution: With the massification of industry, assembly line production became the main mode of production, and mass-produced goods replaced personalized customization. This mode of production can significantly reduce production costs, but it also makes goods less personalized.

The era of information technology: With the development of information technology, consumers' consumption concepts began to change, and the demand for personalized products increased. Enterprises began using information systems, such as CRM (Customer Relationship Management), to carry out mass customization and provide personalized goods.

The current era of the Internet and big data: The development of the Internet and big data technology provides unlimited possibilities for personalized customization. The rise of online shopping platforms and social media has made it easier for consumers to find and buy goods that meet their needs. Enterprises can use big data to conduct accurate marketing and learn the real needs of consumers to provide more personalized products and services.

2.3. Mass Customization

Stan Davis first introduced the concept of "mass customization" in his book: *Future Perfect*. Manufacturers can quickly and fluently integrate demand and customize their products". For the first time, the two different concepts of "push" mass production and "pull" personalization according to customer needs were combined. Mass customization combines push and pull production, in which parts and processes with a high degree of versatility are produced in a large-scale push mode. The parts and processes that are highly versatile are produced in a large-scale push mode, while the parts and processes that are customized to the customer's needs are produced in a pull mode. Through the perfect production line and supply chain integration to maintain sustained low-cost and high efficiency, through real-time demand transfer and high-density department connection to maintain information communication and information accuracy, the advantages of mass production and personalized customization of the organic combination of the implementation of delayed strategy and agile manufacturing, for a more segmented market. The company can offer various choices in a customized market and maintain consistent product quality. There are at least four requirements for mass customization capabilities: first, the industry can mass produce the product; second, the industry does not have large fluctuating cost changes during the customization process; third, the production line can respond quickly to the demand; and lastly, it can produce the product with the required customized content [5].

As for the way of mass customization, nowadays, there are different opinions. Some scholars believe that mass customization can be customized. Products can be divided into four forms: cooperative, adaptive, decorative and transparent, and some scholars believe that mass customization needs to be divided into design customization, manufacturing customization, assembly customization and sales customization. Mass customization is influenced by technology base, big data analysis capability, supply chain management capability, data-driven, intellectual capital, departmental cooperation, employee participation, etc., all affecting the enterprise's mass customization capability. Scholars have categorized the influencing factors into two main groups: technological and supply chain factors.

People usually refer to manufacturing and information technology among the technological factors. For firms, a commitment to productivity can reduce costs and withstand the pressure of price competition, thus gaining more market share. If prices remain constant, an increase in productivity means an increase in profits. Only with higher productivity can a firm be truly competitive and not be replaced by competing peers. Advanced manufacturing technologies can increase productivity, intuitively enhance competitiveness, and improve mass customization. In addition, mass customization cannot be separated from implementing the "delay strategy." This strategy can be accomplished by moving the order separation point, reducing the manufacturing process's complexity, reducing the supply chain's uncertainty, and thus reducing the inventory of finished goods. Therefore, technical factors directly impact production efficiency, which in turn affects the enterprise's mass customization ability. In information technology, digital technology has the characteristics of omnidirectional perception, whole-process coding, industry-wide transversal penetration and inheritance, and significant network effects. While implementing the "delay strategy," we can quickly obtain customer needs and complete the customization process. The immediacy of data and

information collection, transmission, analysis and interaction brought by information technology makes the transmission and flow of materials, goods, services and funds among various links more accurate and efficient. It completes the connection between departments, leaders and workers, and enterprises and customers, which makes mass customization more efficient.

In the supply chain factor, the primary task of the supply chain manager is to respond to the customer's requirements faster, more accurately, and more uniquely to complete the task; the challenge is that the supply chain has developed from the inter-organizational and linear processes between suppliers, manufacturers, and customers to a complex global ecosystem consisting of manufacturers, suppliers, customers, distributors, and other trading partners [6]. In mass customization, customer service management, product mix management, inventory management, spend and sourcing management, pricing and promotions management, logistics and distribution management are all competitive points that can quickly establish an advantage, reduce costs, and improve quality.

2.4. Big Data Analysis for Mass Customization

McKinsey & Company, a world-renowned consulting firm, first proposed the "Big Data" era concept. McKinsey said: "Data has permeated every industry and business function today and has become an important factor of production." Big data technology capabilities refer to the use of new tools and new methods to extract knowledge and information from big data; the value of big data is not only in the technical aspects of the advantages but also in the big data assets and human resources, business processes and organizational structure of the interplay. Big Data development so far, "big data capabilities", "analytical capabilities", "business intelligence analysis", and "big data and predictive analytics " are several important issues that are still popular research subjects [5].

In the face of mass customization, big data will play a role mainly through three parts: first, big data technology capabilities. Enterprises adopt new tools, introduce new talents and implement new policies to enhance the ability to obtain information from data. Second, big data management capability. Strong big data management capability proves that an enterprise can identify potential opportunities, potential problems, and potential needs. In mass customization, strong big data management capability is the ability of an enterprise to stand in a competitive environment that is difficult for competitors to imitate and learn from. Finally, big data to promote decision analysis capabilities. Big data decision analysis is built based on big data technology. The results and analysis of the intuitive display in front of the decision-makers is the most important part of the enterprise big data operation, so enterprises benefit from big data, enhancing the analysis of mass customization.

2.5. Intelligent Manufacturing

Intelligent manufacturing refers to the product's entire life cycle as the object to achieve a pan-awareness of the situation to achieve information technology production and manufacturing. Intelligent manufacturing technology is built based on modern sensing, Internet, full automation plus anthropomorphic intelligence technology and other latest technologies through intelligent identification, human-computer interaction technology, decision-making and execution technology to achieve the intelligence of the design process and manufacturing process. It is a comprehensive combination and integration of information technology, intelligent technology and equipment manufacturing technology, which makes manufacturing automation more intelligent and highly integrated [7]. In the twenty-first century, the rapid development of the Internet, new energy, big data and other technologies thus made a huge change in society and the human production industry so that the standard of living of human society is at a higher level. Intelligent manufacturing has brought many benefits to mass customization:

Improvement of production efficiency: Smart manufacturing can realize automated and intelligent production, and through technologies such as robots, automated equipment and the Internet of Things, production efficiency can be greatly improved. This allows companies to meet the individual needs of different customers in a short period.

Reducing Costs: Traditional mass production often requires many fixed assets and human input, while smart manufacturing can reduce manual operations and resource waste. Through flexible production line configuration, intelligent scheduling and optimization algorithms, production costs can be reduced, and scrap and wastage can be reduced.

Improve product quality: Intelligent manufacturing utilizes advanced sensors, data analytics and monitoring systems to monitor product quality in real-time and make timely adjustments to the production process [8]. This helps to improve product consistency and stability, reduce defect rates, and improve customer satisfaction.

Accelerated delivery: Traditional mass production usually requires a long lead time to meet market demand, while smart manufacturing can achieve rapid response and flexible adjustment. Through digital design, virtual simulation, rapid prototyping and other technologies, it can shorten the product development and production cycle and improve delivery speed.

Realize personalized customization: Intelligent manufacturing can be personalized according to customer demand, and through flexible production lines and intelligent configuration, it can flexibly produce products with different specifications, styles and functions. This helps meet consumers' diversified needs and enhance market competitiveness [9]. Taking automobile manufacturing as an example, the production line can flexibly produce cars with different engines, colors and interior styles according to consumers' specific configuration requirements, enabling users to get customized products that fully meet their personal preferences.

BMW is the world's first enterprise to carry out mass customization of automobile production. BMW makes full use of intelligent manufacturing technology to realize the automation and flexibilization of production lines, which can not only produce different models of cars but also personalize each car according to the needs of consumers [10].

In short, smart manufacturing brings many benefits to mass customization, including improving efficiency, reducing costs, improving quality, speeding up delivery and enabling personalization. These benefits enable companies to meet market demands better and maintain a competitive edge in the face of fierce competition.

3. Future Prospects

3.1. Prospects and Opportunities

More accurate demand forecasting: With the development of technology and the accumulation of data, big data analytics supply chain demand forecasting models will become more accurate. The prediction models can better capture market trends and consumer behavior using more data sources and finer algorithms, thus providing more accurate demand prediction results [9].

Real-time decision support: Big data analytics supply chain demand forecasting models can provide real-time data analysis and decision support to help companies better respond to market changes and demand fluctuations. By monitoring and analyzing data in real-time, enterprises can adjust production plans, inventory management and logistics operations to meet market demand [11].

Intelligent supply chain management: Big data analytics supply chain demand forecasting models can be combined with other intelligent technologies to achieve intelligent supply chain management. For example, combined with IoT technology, it can monitor and track the status and location of goods during logistics transportation in real time; combined with artificial intelligence technology, it can automate various decisions and operations in the supply chain.

3.2. Challenges

Firstly, the demand forecasting of the supply chain should provide reliable service; secondly, the risk control ability of supply chain management demand forecasting is poor, and the visualization is insufficient; thirdly, the whole supply chain is still insufficiently coordinated after demand forecasting, and it is difficult to connect and optimize it digitally. As for demand forecasting, it is difficult to achieve accurate forecasting due to the influence of product type, geography, inventory, etc.; the lack

of user participation and uncertainty of user demand is still a great challenge, and it is difficult to satisfy the customer's requirements in terms of depth and comprehensiveness of demand analysis.

4. Conclusion

In conclusion, integrating big data analytics into the supply chain mass customisation field holds great promise. The shift from manual warehousing to mechanization, automation and intelligence has provided important support to meet the demand for personalized products. Supply chain management requires more refined means against global economic globalization and rapid technological development. The development process from the era of handmade manufacturing to the era of the Internet and big data has led to the realization of mass customization. Smart manufacturing, as the core of Industry 4.0, provides a more efficient, economical, high-quality and faster solution for mass customization. However, these advantages come with challenges, including accurately forecasting demand, managing risk, and enabling supply chain collaboration. However, challenges remain and must be addressed by the joint efforts of academia, industry, and policymakers. Issues such as user engagement, demand uncertainty, and collaboration across the supply chain require systematic solutions. By overcoming these challenges and taking full advantage of the opportunities presented by big data analytics, companies can unleash the full potential of mass supply chain customisation to efficiently and effectively deliver customized products to diverse and demanding markets.

References

- [1] Fienberg, Stephen E. Privacy and confidentiality in an e-commerce world: Data mining, data warehousing, matching and disclosure limitation, 2006: 143-154.
- [2] Runde Daniel F. Recovery with resilience: Diversifying supply chains to reduce risk in the global economy. (2020).
- [3] Machado Carla Gonçalves, et al. Industry 4.0 readiness in manufacturing companies: challenges and enablers towards increased digitalization. *Procedia Cirp*, 2019, 81: 1113-1118.
- [4] Kotha Suresh. Mass customization: implementing the emerging paradigm for competitive advantage. *Strategic Management Journal*, 1995, 16(S1): 21-42.
- [5] Sheng Hongyan, et al. Responding to market turbulence by big data analytics and mass customization capability. *Industrial Management & Data Systems*, 2021, 121(12): 2614-2636.
- [6] Martin Reinhold, Jonathan Crisman. Conjuring Utopia's Ghost. *Thresholds*, 2012, 40: 11-20.
- [7] Tyson Laura D., and John Zysman. Automation, AI & work. *Daedalus*, 2022, 151(2): 256-271.
- [8] Itami Hiroyuki, and Thomas W. Roehl. Mobilizing invisible assets. Harvard University Press, 1991.
- [9] Ronchi Don. Beyond Mechanization: Work and Technology in a Postindustrial Age, by Larry Hirschhorn. *Human Resource Management*, 1985, 24(2): 237.
- [10] Visich John, Qiannong Gu, Basheer M. Khumawala. B2C mass customization in the classroom. *Decision Sciences Journal of Innovative Education*, 2012, 10(4): 521-545.
- [11] Jaikumar Ramchandran. Postindustrial manufacturing. *Harvard Business Review*, 1986, 64(5): 69-76.